## TITLES AND ABSTRACTS OF PAPERS FOR THE
## SEATTLE MEETING OF THE SOCIETY
### JUNE 17-19, 1920

The Pacific Division of the American Association for the Advancement of Science will hold its annual meeting this year at Seattle, Wash. As one of the affiliated societies, the Astronomical Society will hold a meeting at the same time and place. President J. H. Moore has appointed as program committee S. L. Boothroyd, University of Washington (chairman), R. G. Aitken, Lick Observatory, V. M. Slipher, Lowell Observatory, and P. W. Merrill, Mount Wilson Observatory. The committee has arranged for a meeting on Thursday forenoon, June 17th, at which papers of interest to astronomers and physicists will be presented. The American Physical Society has been invited to meet with us at this time. This Society, in turn, invites us to attend its meeting, to be held on Friday forenoon, June 18th. On Thursday afternoon a Symposium on the subject of Relativity has been arranged, which will be of interest to mathematicians, physicists and astronomers. As will be seen from Dr. Plaskett's letter on another page, an excursion to the Dominion Astrophysical Observatory at Victoria, B. C., has been arranged for Saturday, June 19th. It is expected that a short meeting will be held at the Observatory on Saturday afternoon for the presentation of papers relating to spectroscopic work.

Following is a list of the titles and abstracts of papers so far received. Other papers are known to be in course of preparation. The order here is one of convenience and does not indicate the order in which the papers will be presented.

### THE SPECTRUM OF JUPITER
#### By V. M. SLIPHER

Improvements during the last few years in dyes for sensitizing dry plates for the lower spectrum made it possible to extend the photographic study of spectra farther into the longer wave-lengths than could be done at the time of my previous investigation of the spectra of the planets. It is intended to give (with illustrations) the results of observations of the spectrum of *Jupiter*, which reveal several new bands and lines due to the selective absorption of the planet's atmosphere.

PHOTOGRAPHIC OBSERVATIONS OF HUBBLE'S VARIABLE NEBULA
IN MONOCEROS (N.G.C. 2261)
BY C. O. LAMPLAND

Brief descriptions are given of some of the changes exhibited in photographs of the nebula taken with the 40-inch Lowell reflector during the past four years. The paper is illustrated by lantern slides.

ON A FORM OF DOUBLE-SLIDE PLATE CARRIER
BY C. O. LAMPLAND

A short description, illustrated by lantern slides, will be given of a form of double-slide plate carrier used with the 40-inch Lowell reflector.

VISUAL AND PHOTOGRAPHIC OBSERVATIONS OF JUPITER, 1919-1920
BY E. C. SLIPHER

Illustrated with slides.

THE SPECTROSCOPIC ORBIT AND DIMENSIONS OF THE ECLIPSING
VARIABLE U CORONAE
BY J. S. PLASKETT

Altho the photometric orbit of this star indicates that the bright component contains about 85% of the light the spectrum of the fainter is plainly visible indicating the necessity of further photometric work. The brighter star has a diameter of 3.1 and the fainter 4.8 times that of the Sun, while their masses are respectively 4.5 and 1.7 times that of the Sun. The spectrum is very diffuse and difficult to measure but sufficient plates were obtained to give reliable values. The difference between spectroscopic and photometric phases in this star, a quantity which has been found to vary irregularly in other eclipsing variables, is probably not greater than the unavoidable error in the spectroscopic orbit.

NOTES ON SOME SPECTROSCOPIC BINARIES
BY W. E. HARPER

THE ORBIT OF THE SPECTROSCOPIC BINARY H. R. 6169
BY R. K. YOUNG

THE INTENSITY OF THE HYDROGEN LINES AND THE CONTINUOUS
SPECTRUM IN γ CASSIOPEIAE
BY H. H. PLASKETT

The intensities are determined on an absolute scale independent
of the luminosity curve of the photographic plate by means of a
method devised by Merton and Nicholson. The essential features
of the method are the use of a neutral tint wedge in front of the slit
of the spectrograph and the calibration of the plate by means of
the spectrum of the positive crater of the carbon arc. A comparison
of the intensity decrement of the Balmer Series under stellar and
laboratory conditions is given, and an indication of the use of this
method for the determination of stellar temperatures.

THE PRINCIPLE OF GENERAL RELATIVITY
BY E. T. BELL

Statement of the principle, the relation to Einstein's work of
1905-12, especially in connection with the field equations of electro-
dynamics. Invariance of the laws of nature and the Calculus of
tensors for the finding of natural invariants. The equivalence
hypothesis and gravitational fields. Uniqueness of the part played
by gravitation in Einstein's general theory. The manner in which
the gravitational field, or the hypothesis regarding it, determines
the curvature of space and its particular non-Euclidian nature.
The identity of time and space.
The presentation will be with a minimum of mathematics.

THE ASTRONOMICAL BEARING OF THE THEORY OF GENERALIZED
RELATIVITY
BY CHARLES E. ST. JOHN

The Michelson-Morley experiment.
The motion of the perihelion of *Mercury* and the various attempts
to reconcile it with the Newtonian law of gravitation.
The deflection of light in passing thru the near neighborhood of
the Sun, as evidenced by the British observations of the eclipse of
May, 1919.
The now critical question of the displacement of all solar lines to
the red in accordance with the requirements of the Einstein law of
gravitation.

THE SPECTROSCOPIC COMMITTEE OF THE DIVISION OF PHYSICAL
SCIENCES OF THE RESEARCH COUNCIL
BY CHARLES E. ST. JOHN, Chairman Western Group

An account of the organization of the Research Committees of
the Division of Physical Sciences upon the Rockefeller fund.

The formation and membership of the Spectroscopic Committee
and its division into Eastern and Western groups.

Plans for stimulating interest and activity in spectroscopic
research and for correlating efficiently the activities of the different
centers of spectroscopic research.

CONCERNING TABLES OF SOLAR WAVE-LENGTHS IN THE INTER-
NATIONAL SYSTEM
BY CHARLES E. ST. JOHN AND HAROLD D. BABCOCK

The solar wave-lengths in the Rowland System are compared with
iron arc wave-lengths in the International System. It is shown
that the lack of homogeneity of the Rowland System is so great
that for present-day precision no satisfactory method is available
for reducing the present tables of solar wave-lengths to the Inter-
national System.

The methods of obtaining a homogeneous system of solar stand-
ards are discussed and data showing the precision to be expected
are given.

A plan for coöperation in the production of the completed tables
is outlined.

THREE SPECTROSCOPIC BINARY STARS
BY R. F. SANFORD

The following three stars were announced to be spectroscopic
binary stars by Adams and Joy in *A. S. P. Publ.* **31**, 40, 1919. Brief
statements are given below concerning the elements derived for
their orbits.

O Σ 82 (1920: $\alpha 4^h 18^m.2$    $\delta +14° 52'$    mag. 7 0)

This is a visual binary star which has completed a considerable
part of a revolution since first observed. The elements of the visual
orbit are still in considerable doubt, the period derived by three
different computers ranging from 90 to 158 years. Star A is the
spectroscopic binary. Star B, distant $0''.7\pm$, is of 9.0 mag., too
faint to produce any effect in the time necessary to photograph the

spectrum of A.   Only one spectrum shows; its class is $F_8$, with moderately good lines.   The period that best fits the observations is 4.0000 days.   This made it possible to get observations for only four sections of the velocity curve but luckily two of these cover the regions of maximum and minimum velocities.   The following provisional elements were obtained from 15 spectrograms taken with one-prism dispersion and an 18-inch camera.   The observations extend over almost 200 revolutions of the star in its orbit.

$$
\begin{array}{ll}
P & 4.0000 \text{ days} \\
e & 0.06 \\
\omega & 12°.74 \\
K & 36.1 \text{ km. per sec.} \\
\gamma & +37.4 \text{ km. per sec.} \\
T & \text{J. D. } 2,422,274.812 \\
a \sin i & 1,980,000 \text{ km.} \\
\dfrac{m^3 \sin^3 i}{(m+m_1)^2} & =0.0193 \odot
\end{array}
$$

The system is of further interest because its proper motion, radial velocity and position in the sky identify it as a member of the *Taurus* Stream.   The importance of a knowledge of the radial velocity and spectral type of star B is realized of course and an attempt will be made to determine them.

205 *Draconis* (1920: $\alpha\ 18^h 45^m.4$    $\delta +49°21'$    mag. 7.2)

Thirty spectrograms of this star have been obtained.   They show that both stars are of Class $F_2$ and give lines very slightly, if at all, different in intensity.   The following elements resulted from corrections to the preliminary elliptical elements by a least squares solution:

$$
\begin{array}{ll}
P & 3.7647 \text{ days} \\
e & 0.00 \\
K_1 & 97.7 \text{ km.} \\
K_2 & 98.3 \text{ km.} \\
\gamma & -18.8 \text{ km. per sec..} \\
T & \text{J. D. } 2,422,159.769 \\
a_1 \sin i & 5,058,000 \text{ km.} \\
a_2 \sin i & 5,089,000 \text{ km.} \\
m_1 \sin^3 i & 1.48 \odot \\
m_2 \sin^3 i & 1.47 \odot
\end{array}
$$

$T$ is the epoch of maximum positive velocity for star one.

These elements give computed velocities for the observational dates that are in as good agreement with the observed velocities as the nature of the spectra would lead one to expect.   More than 165 revolutions in the orbit of this star separate the first and last observations of the radial velocity.

Boss 5591   (1920: $\alpha\ 21^h 40^m.8$    $\delta +28°24'.8$    mag. 6.9)

Nineteen spectrograms of this star have been secured. They show both stars to be of the same spectral class, $F_0$, and that the lines due to each are of approximately equal intensity. Elements have been derived as follows:

$$
\begin{array}{ll}
P & 3.7486 \text{ days} \\
e & 0.19 \\
\omega & 82.66 \\
K_1 & 93.4 \text{ km. per sec.} \\
K_2 & 92.1 \text{ km. per sec.} \\
\gamma & +4.18 \text{ km. per sec.} \\
T & \text{J. D. } 2,422,175.158 \\
a_1 \sin i & 4,728,000 \text{ km.} \\
a_2 \sin i & 4,662,000 \text{ km.} \\
m_1 \sin^3 i & 1.17 \odot \\
m_2 \sin^3 i & 1.19 \odot
\end{array}
$$

The observed velocities, extending over an interval of about 100 orbital revolutions, conform to the computed velocities as well as can be expected from the nature of the spectra and the consequent blending of lines at certain phases.

### RELATIVE WAVE-LENGTHS OF SKYLIGHT AND VENUS-REFLECTED SUNLIGHT

#### BY CHARLES E. ST. JOHN AND SETH B. NICHOLSON

Spectrograms of *Venus* have been secured at Mount Wilson Observatory when *Venus* was east of the Sun in 1919 and when west of the Sun in 1919-20. Thirty lines in the region $\lambda$ 4500 in the *Venus* spectrum have been compared with the same lines in the spectrum of the sky. This comparison shows differences of wave-length that are just at the limit of observation, an average shift of the *Venus* lines of 0.002 angstroms to the violet.

The results are discussed in relation to the altitude of *Venus* and, in view of a possible bearing upon generalized relativity, in relation to the positions of Earth, Sun and *Venus*. The effect of an increasing amount of superposed skylight is also considered.

### RADIAL VELOCITIES AND PARALLAXES OF ADDITIONAL STARS IN THE TAURUS GROUP

#### BY WALTER S. ADAMS, ALFRED H. JOY, GUSTAF STRÖMBERG

Observations of the spectrum of twenty-five stars in the cluster of the *Hyades*, whose proper motions correspond to those of stars belonging to the *Taurus* group, have been made with the 60-inch and 100-inch reflectors. Included among these are the four bright

K-type stars: $\gamma$, $\delta$, $\epsilon$ and $\theta'$ *Tauri*. The results indicate that nine-teen of the stars observed belong to the group, while three are doubtful and three do not belong or are spectroscopic binaries with a considerable range of velocity. The mean radial velocity for the nineteen stars is $+39$ km. and the average parallax computed spectroscopically is $+0''.021$ with a range of from $0''.013$ to $0''.030$. The apparent visual magnitudes of these stars vary from 3.6 to 8.7 and thus afford an excellent test of the spectroscopic method. The spectral types of the brighter stars with the exception of the four stars already referred to are considerably less advanced than those of the fainter stars. The parallax of the *Taurus* group as derived by Boss is $0''.025$ and that by Kapteyn is $0''.024$.

### The Spectra of Some Companions to Stars of the B-Type
#### By Walter S. Adams, Alfred H. Joy, Gustaf Strömberg

The spectra of the companions of stars of the B-type are of especial interest because of the wide difference in absolute magni-tude shown by such pairs in case they form true physical systems. Observations have been made of the companions of the stars $\epsilon$ *Persei*, $\beta$ *Orionis*, $\delta$ *Orionis*, $\iota$ *Orionis*, $\lambda$ *Orionis*, $\beta$ *Scorpii* and $\beta$ *Lyrae*. To four of these pairs Burnham assigns a common proper motion, while in the case of the other three the connection is uncer-tain. The spectrum of the companion is in every case found to be of the B-type, and for all except the companion of $\beta$ *Orionis* it is of a more advanced type. In the latter case the companion is a close visual binary. The average spectral type of the remaining six brighter stars is $B_2$ and that of their companions $B_6$. The average difference in apparent magnitude, is 3.7 magnitudes, which also cor-responds to the difference in absolute magnitude in case these stars are physical systems. The difference in the case of $\epsilon$ *Persei* is 5.3 magnitudes.

### Summary of Spectroscopic Parallax Determinations
#### By Walter S. Adams, Alfred H. Joy, Gustav Strömberg

The rapid accumulation of parallaxes determined with a high degree of accuracy by the trigonometric method has made it possi-ble to complete a revision of the standards of reduction used in the spectroscopic method and to derive values which may be considered as subject to but little modification in the future. The revision has been based upon a total number of 657 stars with parallaxes deter-

mined by Mitchell, Schlesinger, van Maanen and various observers at the Yerkes Observatory. About 115 of these stars are common to two or more of the observers. The results of the comparison are indicated in the following summary, the differences being taken trigonometric *minus* spectroscopic parallaxes.

|  | Number | Difference | Mean Deviation |
|---|---|---|---|
| Mitchell..................... | 194 | −0″.0006 | 0″.0193 |
| Schlesinger.................. | 287 | −0 .0023 | 0 .0148 |
| van Maanen................. | 78 | +0 .0036 | 0 .0110 |
| Yerkes...................... | 98 | −0 .0032 | 0 .0210 |

A very marked improvement would be introduced into these results by the omission of a few stars of very large parallax for which the errors of the spectroscopic values (which are proportional to the amount of parallax) are comparatively large. This is especially true of the M-type stars of very low luminosity. An additional difficulty in the case of these stars is the necessity for observing their spectra with low dispersion on account of their faintness, and this renders the determination of the intensities of the spectral lines less certain. The omission of four such stars, for example, from the Yerkes list would reduce the difference to −0″.001. The difference in the case of van Maanen is also due in large measure to a very low discordant value.

The agreement of the individual parallaxes derived by the two methods compares very favorably with that found by different observers using the trigonometric method alone; and the small value of the systematic difference from these four excellent series of trigonometric values appears to justify fully the adoption of this system in the reduction of the spectra of about 1700 stars for which data are now available.

PARALLAX NOTES
By ADRIAN VAN MAANEN

MISCELLANEOUS ITEMS RELATING TO THE SPECTRA OF LONG-
PERIOD VARIABLE STARS
By PAUL W. MERRILL

1. A summary of the radial velocity data for about eighty-five stars.
2. The presence of low temperature lines in the absorption spectra.
3. R *Andromedae* and similar stars.
4. R *Aquarii*.

THE FORM OF THE GREEN NEBULAR BANDS IN NOVA AQUILAE III
By J. H. MOORE

The peculiar forms of the $N_1$ and $N_2$ nebular bands obtained
when the slit of the spectrograph was placed in different directions
across the small greenish disk of *Nova Aquilae* III, will be shown
(with slides). A discussion of possible interpretations of the observa-
tions will be given.

OBSERVED CORRECTIONS TO THE RIGHT ASCENSIONS OF THE PRE-
LIMINARY GENERAL CATALOG OF BOSS
By R. H. TUCKER

Observations made at the Lick Observatory in the years 1906-
1908. Two hundred and fifty-five stars from $+38°$ and $-38°$
declination. Eight observations each, both positions of the instru-
ment, fixed circle east and fixed circle west. *Polaris* observed at
both culminations with each night, fifty nights. Systematic cor-
rections with respect to declination only.

THE METEOR CRATER, ARIZONA
By W. W. CAMPBELL

In Central Arizona, twenty miles west of Winslow and six miles
south of the Santa Fe railway, is a remarkable hole in the ground,
circular in form, about 4200 feet in diameter, its bottom about
400 feet lower than the general level of the surrounding plains. The
rim of the hole is from 130 to 160 feet higher than the surrounding
plains, and the surface outside of the rim slopes down, in from one-
quarter to half a mile, to the general level. Thousands of iron
meteorites, varying from individuals weighing several hundred
pounds down to grains of minute weight, have been found in all
directions from this hole and a few within the hole. The general
form of the hole and its rim resembles that of the lunar craters com-
parable in size with it. The Arizona crater has been studied by
geologists but not by astronomers. Geologists are divided in
opinion as to its origin: some favor the hypothesis of origin by
internal explosion, such as by steam under high pressure, others
advocate an origin by meteoric impact. The present paper dis-
cusses the merits of these hypotheses, and provisionally favors the
meteoric origin. Twenty minutes, with lantern slides.

### Preliminary Orbits of Four Binary Stars
#### By R. G. Aitken

The stars are $\beta$ 552, $\Sigma$ 412, $\beta$ 1185, O$\Sigma$ 341. The observed motion in the first two extends over considerably less than one revolution but the elements now derived, while preliminary, are regarded as fair approximations. These two orbits are of average eccentricity and inclination to the plane of projection.

The other two orbits are alike in being highly inclined to the plane of projection but present a marked contrast in the eccentricity, one being rounder than the orbit of *Mercury*, the other ranking with that of $\zeta$ *Boötis*, the double-star orbit having the largest eccentricity heretofore known. The periods of these two systems are accurately determined and the major axes are also fairly determinate. Unless the masses are much greater than the average, it follows from the orbit data that both stars have measurable parallaxes.

### Observations of the Spectrum of Omicron Ceti in 1919
#### By C. D. Shane

### Comet c 1915 (Taylor)
#### By H. M. Jeffers